

LEARNING TO HEAL THROUGH ART THERAPY: MILITARY SERVICE MEMBERS PRESENTING CLOSURE AND HEALING MASK THEMES HAVE HIGHER CONNECTIVITY BETWEEN BRAIN REGIONS ASSOCIATED WITH MEMORY AND PAIN

Janell Payano Sosa^{1, 2, 3}, Rujirutana Srikanthana¹, Melissa Walker^{1, 2}, Adrienne Stamper^{1, 2, 3}, Kayleigh Scott^{1, 2, 3}, Juliet King⁴, John Ollinger¹, Grant Bonavia¹, Alexander Christensen⁵, Clifford Workman⁵, Kohinoor Darda⁵, Anjan Chatterjee⁵, Chandler Rhodes¹

1 National Intrepid Center of Excellence, Walter Reed National Military Medical Center, 2 Creative Forces®: National Endowment for the Arts Military Healing Arts Network, 3 Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., 4 George Washington University, Department of Art Therapy, 5 Penn Center for Neuroaesthetics, Perelman School of Medicine, University of Pennsylvania

INTRODUCTION

- Military service members (SMs) exposed to combat-related traumatic events have an increased risk of developing posttraumatic stress symptoms.
- Traumatic memories are typically encoded on an unconscious level and are not easily accessible through verbal recall.
- Art therapy is a promising intervention that allows SMs with posttraumatic stress to explore their trauma through art-making and reflection in a psychotherapeutic relationship with an art therapist [1, 2].

Hypothesis: Specific neurobiological markers are associated with the theme of psychological closure and/or healing of traumatic memories as represented in the masks created during art therapy.

METHODS

Population: This study includes retrospective data from 113 SMs attending the NICoE four-week Intensive Outpatient Program (IOP) [3] who participated in group and individual art therapy sessions, self-report assessments, a traumatic brain injury history (TBI) assessment, and an advanced MRI scan.

Art Therapy: Art therapy is defined as “an integrative mental health and human services profession that enriches the lives of individuals, families, and communities through active art-making, creative process, applied psychological theory, and human experience within a psychotherapeutic relationship” [2].

Self-report Assessments:

- **Neurobehavioral Symptom Inventory (NSI):** Post-concussive symptoms [4,5]
- **PTSD Checklist: Military Version (PCL-M):** Posttraumatic stress symptoms [6]
- **Generalized Anxiety Disorder (GAD-7):** Generalized anxiety symptoms [7]
- **Patient Health Questionnaire-9 (PHQ-9):** Depression symptoms [8]

Thematic Analysis: Art therapy masks were coded by three independent coders for 23 individual themes based on themes identified in [1]. Presence or absence of each theme was determined from review of mask image and clinical notes. This analysis includes only the results for the theme of psychological closure and/or healing.



Figure 1: Example of psychological closure and/or healing theme. Title: “Out of Darkness and Despair, A Shimmer of Light” “I felt a sense of relief and felt like I could move forward and be at peace with my past.”

Neuroimaging:

- High resolution 3D T1-weighted anatomical and resting state functional MRI were obtained during the 2nd week of the IOP
- Standard preprocessing was completed with SPM12 [9] and functional connectivity analysis was analyzed using the CONN Functional Connectivity Toolbox [10].
- Analysis focused on the following brain regions:
 - Default Mode network (DMN)
 - Dorsal Attention Network (DAN)
 - Amygdala
 - Hippocampus
- Functional Connectivity Analysis
 1. Whole Brain Functional Connectivity Analysis
 2. Region of Interest (ROI) to ROI

Statistical analysis: Participants were divided into groups based on the presence (Closure group) or absence (Closure Absent group) of the theme of psychological closure and/or healing. Group differences in demographics and self-report measures were assessed using independent samples t-tests or chi-square tests as appropriate.

RESULTS

Demographics

Characteristic	Total	Closure group	Closure Absent group	p-value
Participant total (n)	104	36	68	
Mean age (SD)	40 (5.7)	40 (6.8)	41 (5.1)	.523
Gender (Male n/Female n)	103/1	36/0	67/1	.465
Average TBI count (SD)	1.7 (1.6)	1.8 (1.6)	1.3 (1.3)	.527
Mean years of education (SD)	15 (1.9)	15.2 (1.9)	15.9 (1.8)	.859
Service Branch (n)				
Army	27	8	19	
Navy	66	23	43	.819
Marines	4	2	2	
Air Force	7	3	4	
Special Operations Status (%)	77	61	85	.005

Table 1. Demographics. Data from n=9 participants removed due to poor quality of imaging and/or registration.

Self-report Symptoms

	Closure Mean (SD)	Closure Absent Mean (SD)	p-value
Admission			
NSI	37.72 (16.1)	36.38 (14.0)	.660
PCL-M	44.25 (14.4)	45.29 (13.5)	.733
GAD-7	12.19 (5.6)	11.32 (5.2)	.429
PHQ-9	10.89 (5.9)	10.26 (4.8)	.563
Discharge			
NSI	20.77 (13.9)	22.27 (12.6)	.602
PCL-M	34.75 (14.2)	36.15 (13.5)	.679
GAD-7	6.07 (5.3)	6.24 (4.5)	.870
PHQ-9	5.72 (4.8)	5.48 (3.7)	.797
*Change Score			
NSI	16.85 (12.0)	14.27 (11.7)	.399
PCL-M	10.23 (11.2)	6.46 (10.3)	.236
GAD-7	6.24 (4.6)	4.80 (3.7)	.196
PHQ-9	5.22 (4.7)	4.78 (4.5)	.580

Table 2. Self-report Measures. *Change score = admission score – discharge score.

- **No group differences noted in self-reported symptoms**

Whole Brain Functional Connectivity

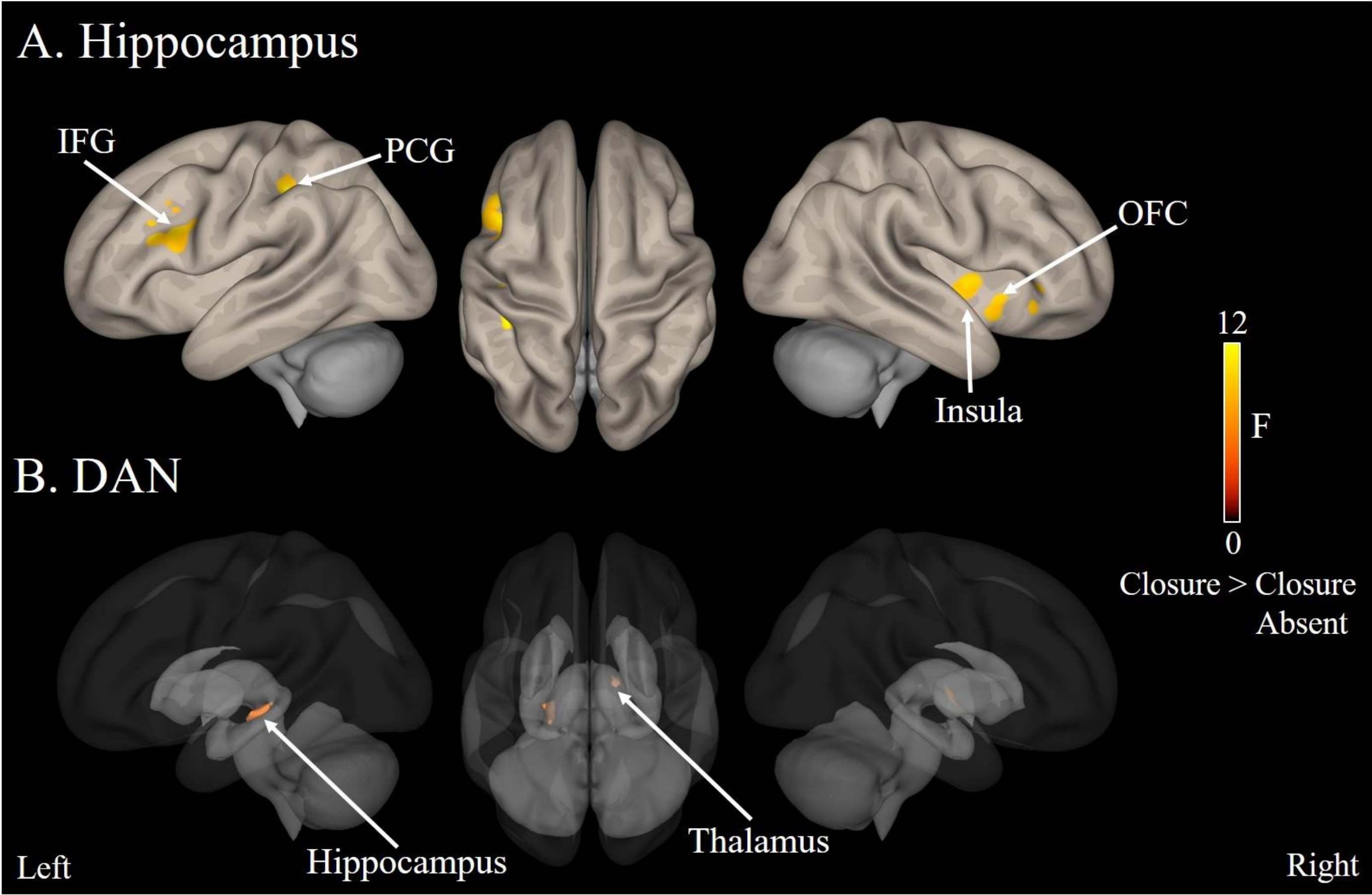


Figure 2. Regions of increased functional connectivity in the Closure group compared to the Closure Absent group. A. Hippocampus. B. DAN. A cluster-forming threshold was set to an uncorrected voxel threshold of $p < 0.001$, and an FDR corrected cluster threshold of $p < 0.05$. IFG: inferior frontal gyrus; PCG: postcentral gyrus; OFC: orbitofrontal cortex.

- **SMs who depicted the theme of psychological closure and/or healing within their art therapy masks demonstrated increased functional connectivity between regions associated with attention (DAN), memory (hippocampus), language (left inferior frontal gyrus) and pain processing (insula, thalamus, postcentral gyrus).**

ROI to ROI Functional Connectivity

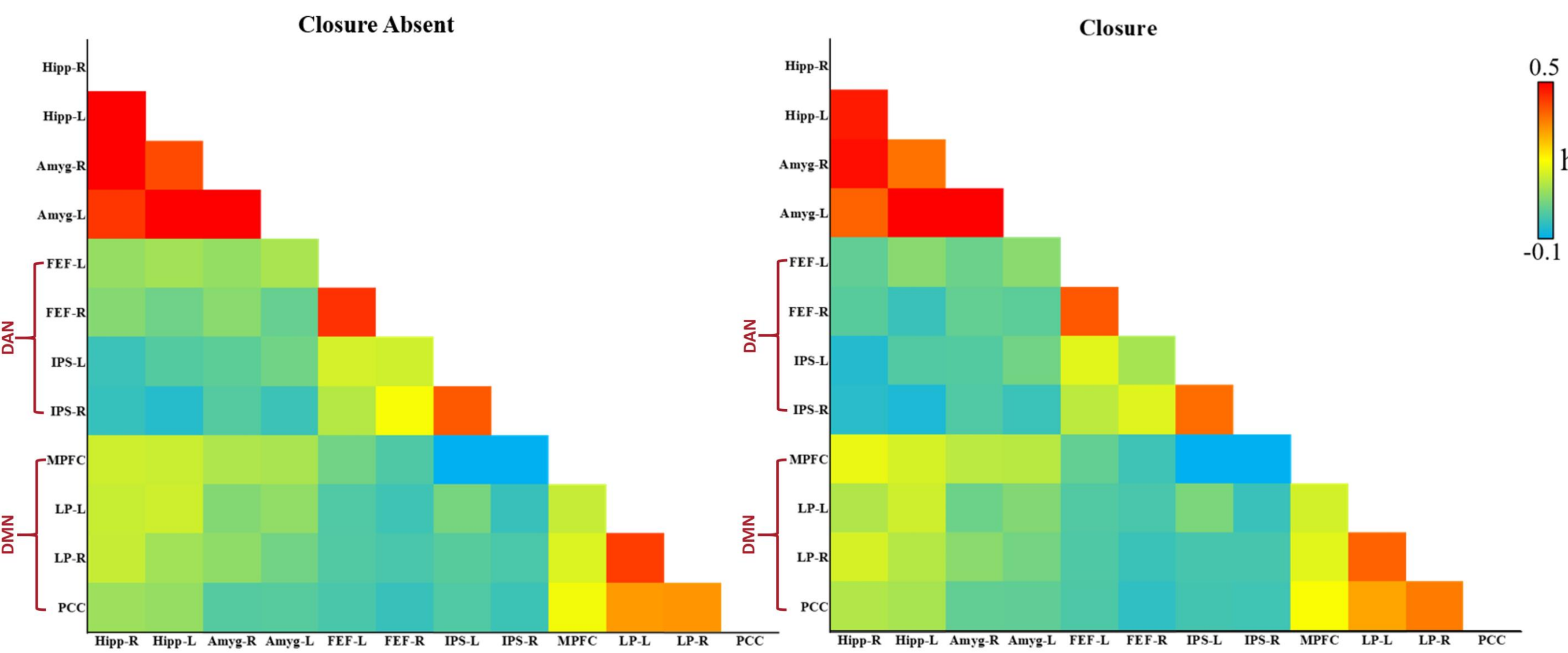


Figure 3. Functional connectivity matrices representing pairwise correlations between all ROIs in the DAN, DMN, Hippocampus and Amygdala. Hipp: hippocampus; Amyg: amygdala; FEF: frontal eye fields; IPS: intraparietal sulcus; MPFC: medial prefrontal cortex; LP: PCC: posterior cingulate cortex; LP: lateral parietal cortex; -R: right; -L: left.

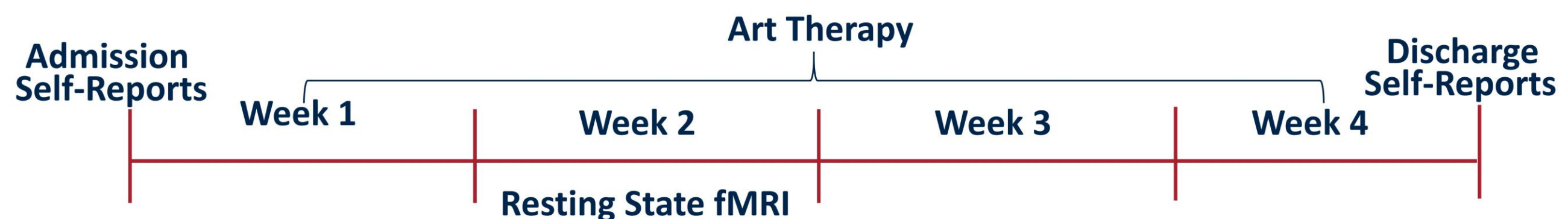
- **No differences in ROI to ROI functional connectivity**

CONCLUSION

Alterations in network functional connectivity measures were identified for SMs expressing closure and/or healing within masks created during art therapy.

LIMITATIONS

- Variable participation in art therapy sessions
- Data collected as part of larger integrative IOP and therefore additional healing and/or closure may have been achieved by SMs through other aspects of the program that would not be captured in the thematic coding of art therapy masks
- Time frame of data collected



FUTURE DIRECTIONS

Future work investigating the direct impact of art therapy and associations of thematic representations within art therapy products on symptom presentation is needed to more accurately investigate the causal impact.

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REFERENCES

1. Walker, M. S., Kaimai, G., Gonzaga, A., Myers-Coffman, K. A., & DeGraba, T. J. (2017). Active-duty military service members' visual representations of PTSD and TBI in masks. *International journal of qualitative studies on health and well-being*, 12(1), 1267317. 2. About Art Therapy. (2017). American Art Therapy Association. <https://arttherapy.org/about-art-therapy/>. 3. DeGraba TJ, Williams K, Koffman R, Bell JL, Pettit W, Kelly JP, Ottimer TA, Nussbaum G, Grammer G, Bleiberg J, French LM, Pickett TC. (2021). Efficacy of an Interdisciplinary Intensive Outpatient Program in Treating Combat-Related Traumatic Brain Injury and Psychological Health Conditions. *Front Neuro*, 11:580182. 4. Ciccone, K.D. and K. Karimur. (1995). Persistent postconcussion syndrome: The structure of subjective complaints after mild traumatic brain injury. *J. Head Trauma Rehabil*, 10, 1-17. 5. Lu, L. H., Cooper, D. B., Reid, M. W., Khoshdel, B., Tsagaratos, J. E., & Kennedy, J. E. (2019). Symptom Reporting Patterns of US Military Service Members with a History of Concussion According to Duty Status. *Archives of clinical neuropsychology: the official journal of the National Academy of Neuropsychologists*, 34(2), 236-242. 6. Weathers, F.W., Huska, J.A., Keane, T.M. (1991). PCL-M for DSM-IV. Boston: National Center for PTSD - Behavioral Science Division; 7. Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*, 166(10), 1092-1097. 8. Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine*, 16(9), 606-613. 9. Penny, W. D., Friston, K. J., Ashburner, J. T., Kiebel, S. J., & Nichols, T. E. (2005). Statistical Parametric Mapping: The Analysis of Functional Brain Images (1st ed.). Academic Press; 10. Whitfield-Gabrieli, S., & Nieto-Castanon, A. (2012). Conn: a functional connectivity toolbox for correlated and anticorrelated brain networks. *Brain connectivity*, 2(3), 125-141.